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Hydraulic fracturing: insights from field, lab, and numerical studies

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Disclaimer

Hydraulic fracturing: insights from field, lab, and numerical studies (H18: Challenges in Hydraulic Fracturing of Unconventional Reservoirs)

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Hydraulic fracturing has become an increasingly important technique in stimulating reservoirs for gas, oil, and geothermal energy production. In use commercially since the 1950's, the technique has been widely lauded, when combined with other techniques, for enabling the development of shale gas resources in the United States, providing a valuable and extensive source of domestic energy. However, the technique has also drawn a degree of notoriety from high-profile incidents involving contamination of drinking water associated with gas extraction operations in the Marcellus shale region.

This work highlights some of the insights on the behavior of subsurface hydraulic fracturing operations that have been derived from field and laboratory observations as well as from numerical simulations. The sensitivity of fracture extent and orientation to parameters such as matrix material heterogeneity, presence and distribution of discontinuities, and stress orientation is of particular interest, and we discuss this in the context of knowledge derived from both observation and simulation. The limitations of these studies will also be addressed in terms of resolution, uncertainty, and assumptions as well as the balance of fidelity to cost, both in computation time (for numerical studies) and equipment / operation cost (for observational studies). We also identify a number of current knowledge gaps and propose alternatives for addressing those gaps.

We especially focus on the role of numerical studies for elucidating key concepts and system sensitivities. The problem is inherently multi-scale in both space and time as well as highly coupled hydromechanically, and, in several applications, thermally as well. We will summarize the developments to date in analyzing these systems and present an approach for advancing the capabilities of our models in the short- to long-term and how these advances can help provide solutions to reduce risk and improve efficiency of hydraulic fracturing operations.

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